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Morphometrical study of the chronocline of Granaria frumentum (Draparnaud, 1801) (Gastropoda: Chondrinidae)

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ABSTRACT. Result of a biometrical study on older and younger Pleistocene and recent Granaria frumentum are presented. A tendency for growth in shell height (0.6 mm/1 mill. year) was found. Normal distribution of the parameters was found for larger samples sizes and signs indicative of selective impregnation were noted.

INTROCUDTION

According to SOÓS (1959), Granaria frumentum (Draparnaud, 1801) in Hungary can be traced down to the lower Pliocene layers. From the Pleistocene it is known from several localities (ROTARIDES, 1931, 1944; HORVÁTH, 1954; SOÓS, 1959; KROLOPP, 1958, 1975, 1976, 1978; DÖVÉNYI, 1973). HORVÁTH (1954) describes it as a common species of the Günz 1/2 interstadial layer of the classical locality at Paks, at a depth of nearly 41 m. LOŽEK (1964), in his comprehensive treatise on the Czechoslovakian Pleistocene, regards the species as frequent in the G/M (Günz/Mindel) interglacial. According to him, it had not become extinct by the beginning of the R/W (Riss/Würm) interglacial, but during the B (Boreal) and A (Atlanticum) period of the Holocene, together the Chondrula tridens (O.F.Müller, 1874), it was dominant, penetrating up to humid, higher altitude regions.

In this paper on the Hungarian Quarternary mollusc fauna, KROLOPP (1973) differentiates 6 faunal phases in the Pleistocene and divides the whole epoch into 14 periods.

Using the Alpines System, he found it to be a frequent species in the Praegünz-Günz, Günz-Mindel interglacials and the Würm I-II interstadial.

Nowadays it is found in habitats varying from humid to faintly humid, warm, avarage temperature between 10°C and 15°C (SOÓS, 1959; LOŽEK, 1964) and the centre of its range is in the Pyrenees. In Hungary, according to the published fauna catalogue, it lives in higher, more humid areas, and occurs only sporadically in the arid Great Hungarian Plain (PINTÉR, RICHNOVSZKY & S. SZIGETHY, 1979).

In Békés county, thoroughly explored by KOVÁCS (1974), it was found in a few localities only.

SOÓS (1959) considered recent specimens to be variable in size, form and teeth.

Based on their experience from research on the Pleistocene mollusc fauna, KROLOPP and LOŽEK recognize a distinct tendency in the morphosis of Granaria of younger and older layers (KROLOPP's pers.comm.).

The purpose of this paper is to prove the above and to provide additional data on changes in shell morphology of the species during the last 1 million years.

MATERIAL AND METHOD

I studied mature specimens with intact mouth from 3 localities of different geological ages. In chronological order:

a/ Kocsola - recent: 43 specimens;

Table 1. Basic statistics of morphological characters of G. frumentum specimens from various localities (H = height, W = width, H/W = measure of elongations, Δ= range of values, Me = median, Mo = mode, σ = standard deviation)

Loc.	Layer	Nr.	H				W				H/W			
			Δ	Me	Mo	σ	Δ	Me	Mo	σ	Δ	Me	Mo	σ
Szabadhidvég, Kavicsos-domb	2.	1- 29	2.4	6.7		0.52	0.6	2.8	2.9	0.14	0.7	2.3	2.4	0.15
	3.	1- 30	2.3	6.7		0.55	0.6	2.8	2.9	0.11	0.7	2.3	2.3	0.17
		31- 60	2.5	6.8		0.64	0.5	2.8	2.8	0.12	0.8	2.3	2.5	0.21
		61- 90	2.1	6.8		0.50	0.5	2.8	3.0	0.12	0.7	2.3	2.3	0.16
		91-120	2.2	6.9		0.52	0.4	2.8	3.0	0.11	0.7	2.3	2.3	0.16
		121-150	2.1	6.6		0.55	0.3	2.8	2.8	0.11	0.5	2.2	2.3	0.15
		151-180	2.8	6.8	6.7-7.0	0.59	0.4	2.8	2.8	0.11	0.7	2.3	2.2	0.19
		1- 60	2.6	6.7		0.59	0.6	2.8	2.8	0.11	0.8	2.3	2.3	0.19
		1- 90	2.6	6.8		0.56	0.6	2.8	2.8	0.12	0.8	2.3	2.3	0.18
		1-120	2.7	6.8		0.55	0.6	2.8	2.9	0.12	0.8	2.3	2.3	0.17
		1-150	2.7	6.8		0.55	0.6	2.8	2.8	0.12	0.8	2.3	2.3	0.17
		1-180	3.0	6.8		0.56	0.6	2.8	2.8	0.12	0.9	2.3	2.3	0.17
	7.	1- 23	2.0	6.7	7.0-7.3	0.50	0.5	2.8	2.8	0.12	0.6	2.3	2.3	0.17
		24- 46	1.9	6.7	6.4-6.7	0.55	0.3	2.8	2.9	0.10	0.5	2.3	2.4	0.18
		1- 46	2.0	6.7	7.0-7.3	0.52	0.5	2.8	2.8	0.11	0.6	2.3	2.4	0.17
Süttő	9.	1- 30	2.6	7.3	7.0-7.3	0.60	0.4	2.9	3.0	0.12	0.7	2.4	2.5	0.19
		31- 60	2.7	7.2	7.0-7.3	0.62	0.5	2.9	2.8	0.14	0.8	2.4	2.4	0.19
		61- 90	2.3	7.3	7.3-7.6	0.56	0.5	2.9	2.9	0.11	0.7	2.4	2.5	0.15
Kocsola	a_1	1- 49	2.2	7.1	7.3-7.6	0.46	0.3	2.8	2.8	0.08	0.6	2.4	2.5	0.15
	a_2	1- 49	2.1	6.9		0.46	0.4	2.8	2.9	0.10	0.8	2.4	2.5	0.16

b/ Süttő 9. - upper Pleistocene, R/W interglacial: 90 specimens;

c/ Szabadhidvég, Kavicsos-domb - Villafranchium (Villanyian-lower Biharian section): 255 specimens:

Serial number of facies: 2. (Fine, sandy desposit)
3. (rough, sandy deposit)
7. (fine, banded, greyish, yellowish clay).

The 388 G. frumentum shells which formed the study material are deposited in the collection of the Hungarian State Geological Institute, Budapest.

I was not in a position to take direct measurements of the fossil material because of the fragile condition of the shells. So I placed them on a 8x8 cm ribbed plate and after photography, I took the measurements from the photos, proportionated 1 to 1, with 0.1 mm precision (max 5% measuring error). It would be unreal to work with higher precision because of longitudinal

erosion and damage of shells. Since the thickness of the shell walls varied between 0.05-0.07 mm, it would have been worthwhile to take the measurements with higher precision.

I measured in mm, the height (H) and width (W) of the shells and calculated the following index and statistics: H/W (elongation), Δ (range of measuring), Me (median), Mo (modus), σ (standard deviation).

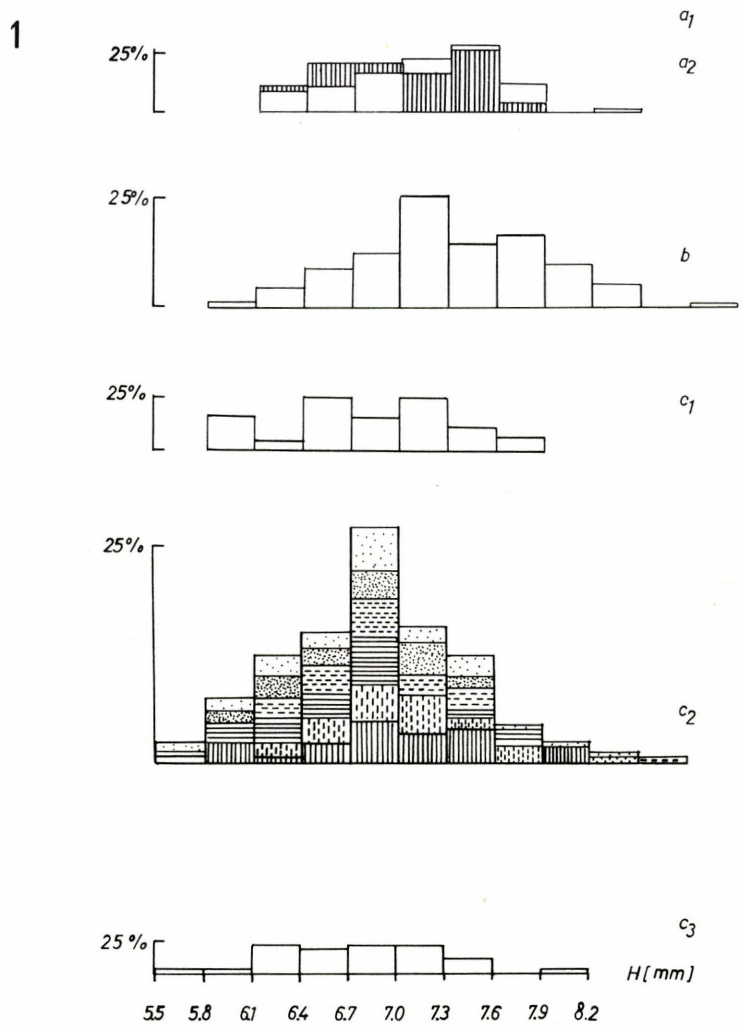

Fig. 1. Histograms constructed from height data (H) of Granaria frumentum from different localities - a = Kocsola (recent) (a_1 values by photographic method; a_2 values direct measurement); b = Süttő (R/W, 9. layer); c = Szabadhidvég (Lower Pleistocene, V) (c_1 = 7. layer, c_2 = 3. layer, c_3 = 2. layer)

RESULTS

Four illustrations depict and a table summarizes the results. The height data of mature specimens from the 3 localities of different ages can be seen in Fig. 1. The class interval of the height values is 0.3 mm. The most frequent frequency-values are about 25% in the samples. As a comparison, I also took direct measurements on the recent material from Kocsola. I presented the results on the same diagram. As can be seen, there is no difference in the modal values and there is only 0.2 mm difference in the medians. Moreover, it can be seen that the values obtained from the measurements are equalized and skewed towards greater values. The greater sample size of the 3. facies from Szabadhidvég, 180 specimens, made it possible to determine optimal sampling. Sampling is optimal if the parameters (H, W, H/W) from a certain sample of the statistical population agree with the parameters of that population (in this case it could not be more than 30 because of the low number of specimens from the other samples).

In the histogram the results concerning the subset of 30 specimens were marked with different symbols.

It can be seen from diagram $1c_2$ and the table that the modes of the subsets are identical, the height-values are little different in median (Me), but decidedly so in the range of measurement (Δ), and in standard deviation (σ). Diagrams $1a_1$ and $1a_2$ show that the recent specimens are not distributed normally, because the mode is skewed towards the larger specimens. In the case of the larger samples (1b, $1c_2$) the distributions are however, normal ($Mo \approx Me$ 0.2), though in the diagram based on a sample of 180 individuals the observed values in the class 7.6-7.9 mm are less than the expected values from the theoretical normal distribution. Selective inbedding is one of the possible explanations - this explanation is substantiated by the rough physical character of the deposit, and by the fact that in case of sample number 2., with impregnated fine deposit, there are nearly equal number of specimens in the different classes ($1c_3$). Finally, mention must be made of the growth in shell height which occurred during the last 1 mill. years.

A comparison of width data (W) may be seen in Fig. 2. The measurements taken by photographic method are skewed towards higher values. In agreement with the above notes, the width values of the specimens interlocated in clay show normal distribution in spite of the relatively low number of specimens (40). It is known that during evaluation of elongation index (H/W) from height and width data, reproducible results can be obtained with less number of specimens (DOMOKOS, 1979). Here, the difference between the direct and indicrect measurements noted for the former two parameters disappeared. The measure deviation consequent to enlargement was not obvious. The distribution of the population from Süttő was also normalized. In case of the population from Szabadhidvég (30_1 - 30_2 - 30_3) I indicated the normal distribution with a dotted line.

As it is shown, considerable deviations are found in larger classes. Deviations already appear in the case of subsets (subsets are marked with dots on diagram 30_2). The probable causes for this inadequancy are selective impregnation or redeposition. Probably the specimens with elongation index of 2.4 and over 7.6 mm in height disappear in greater number during impregnation and redesposition. We can give exact explanation only on completion of actual-paleontological research.

SUMMARY

During morphometrical examination on Granaria frumentum (Draparnaud, 1801), the following results were obtained:

1) From the Villafranchium to present, changes in shell morphology took place in Granaria frumentum (Fig. 4). Namely, height (H) increases nearly 0.6 mm during about 1 million years. Naturally, the elongation index calculated from the height and width data (H/W) increased to nearly 0.15 value, in accordance with increase in the abovementioned character. Probably, evolution was accelerated during the Riss/Würm interglacial. There was no tendency for increase in shell width. The thermophilous Granaria frumentum was distributed more southernaly during colder periods of the Pleistocene and Holocene. This shift in distribution did not affect its morphological changes and did not divert the direction of changes from its original tendency.

2) The present idea formed of the great variability of the species (SOÓS, 1959) is in need of revision.

3) During impregnation and fresh water redeposition (Szabadhidvég), probably selection occurred. The absence of specimens of certain H/W values are indicative of this. During subsequent examinations it will be necessary to compare the intact with detrital shells, to study

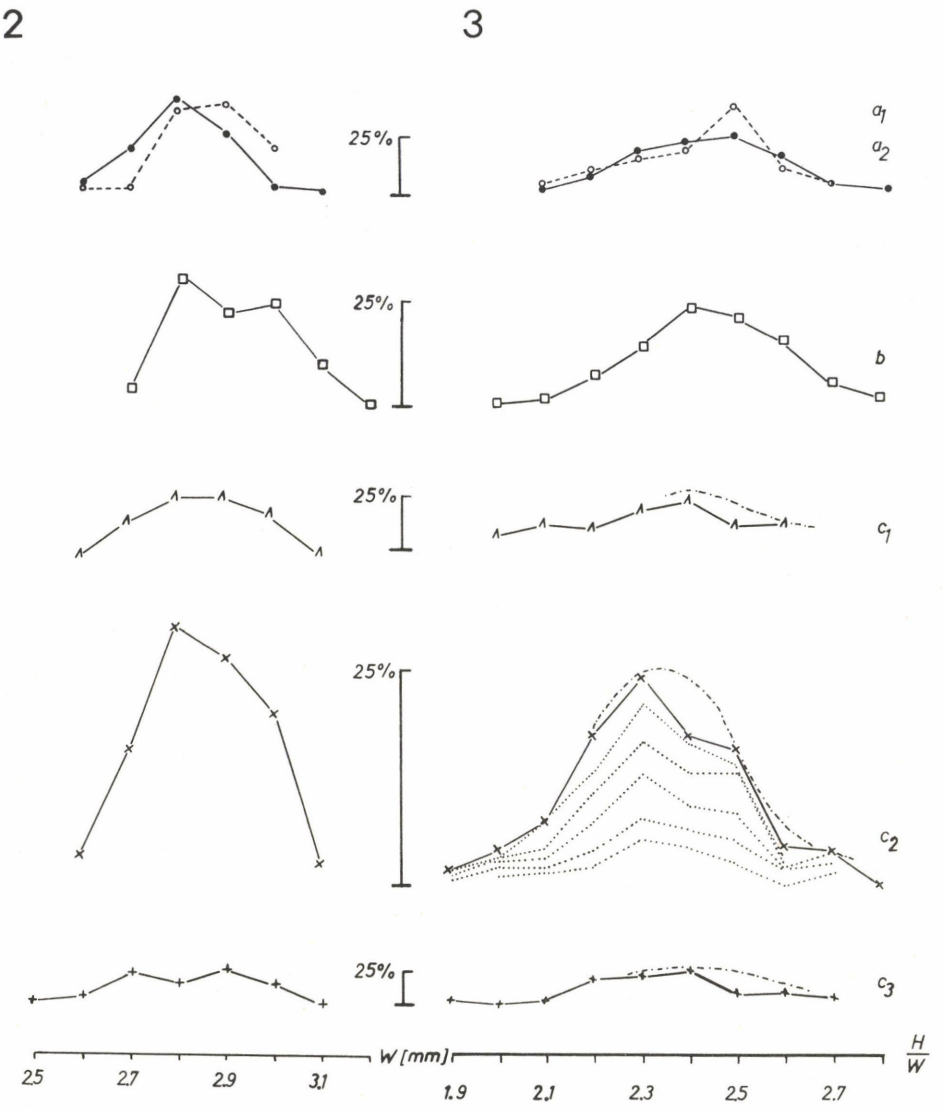

Fig. 2. Frequency distribution curves of width (W) data of Granaria frumentum from different localities (for explanation of symbols, see Fig. 1)

Fig. 3. Frequency distribution curves of elongation (H/W) of Granaria frumentum from different localities (for explanation of symbols, see Fig. 1)

the process of impregnation and to clarify the possible allochtonous occurrence of the mollusc shells (ROTARIDES, 1942; KROLOPP, 1967; SZÓNOKY, 1968). The selection will be irrefutably proved only when the above problems are solved.

4) If the sample size is up to 30, there will be only slight deviations in modal values (Figs 1-3 and Table).

5) The data from photographic measurements were skewed towards higher values.

Finally I thank Dr. Endre KROLOPP (Hungarian State Geological Institute) for providing the study material and for his assistance during the preparation of the manuscript.

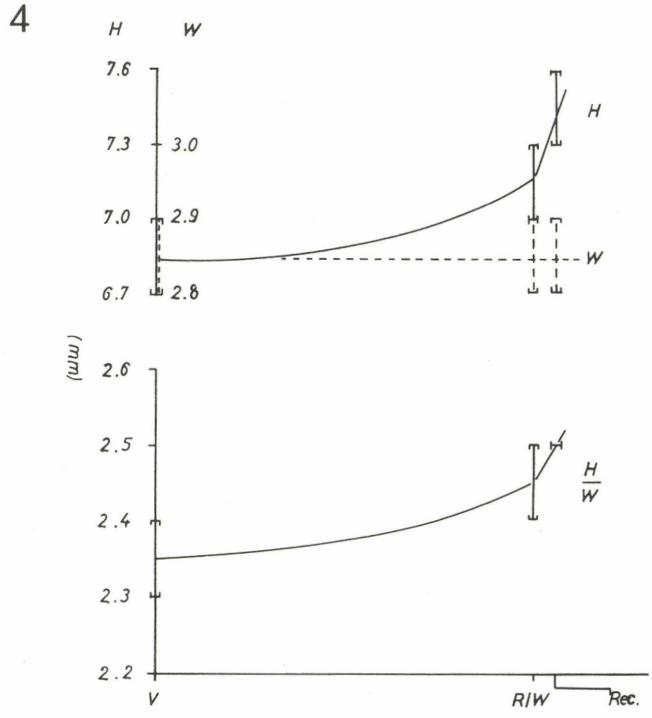

Fig. 4. Temporal changes in the measured parameters (H, W, H/W) (V = Villafranchium, R/W = Riss/Würm, Rec = Recent)

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